			BEV-TE_{95} [mm]			3D-TE_{95} [mm]
Patient	Fractions	PART MV-fields	EPID-PART	XRlog-PART	XRlog-TOT	XRlog-TOT
Lung 1	10	2/6	3.6	4.8	4.8	5.3
Lung 2	3	2/9	3.5	3.7	4.5	4.7
Lung 3	4	6/9	3.9	3.6	4.9	6.4
Lung 4	10	6/6	2.1	2.0	2.0	3.6
Lung 5	4	12/12	4.1	4.3	4.3	4.7
Lung 6	10	3/8	3.1	3.7	3.1	3.6
Lung 7	4	7/9	3.5	3.6	3.8	4.1
Lung 8	4	8/8	3.1	2.8	2.8	5.0
Liver 1	10	5/7	4.2	4.2	4.2	5.3
Liver 2	10	3/6	3.1	3.2	3.0	4.5
Liver 3	10	2/6	2.3	2.0	1.9	4.9
Intra-fraction variability		syst error Σ [mm]	0.32	0.48	0.43	
		random error σ [mm]	1.6	1.7	1.5	
		PTV margin [mm]	3.0	3.3	3.2	
Inter-fraction variability		SD [mm]	0.42	0.54	0.49	

Table 1: summarizes the 95th percentile TE on the BEV (BEV-TE_{95}) [mm] with EPID (EPID-PART) and XR-log file (XRlog-PART) for the part of the MV beams that contained a visible MV marker. Additionally, XR-log file $TE_{95,BEV}$ and 95th percentile TE in 3D (3D-TE_{95}) was calculated for all treatment beams (XRlog-TOT). Further intra-fraction systematic (Σ) and random BEV TE (σ) were listed for both modalities with their corresponding PTV margin (van Herk). To quantify inter-fraction TE variation, standard deviation (SD) of mean TE per fraction was calculated.

Conclusions: A complementary dual-modality verification was applied on 8 lung and 3 liver cancer patients treated with RTTT. BEV-TE_{95} between an independent EPID and XRlog were consistent (intra- and inter-fraction differences were not significant) to guarantee an adequate treatment when using a 5 mm PTV margin.

PO-0930

FLIRT: a software suite for real-time 2D/3D image registration for image guided radiotherapy

H. Furtado[1,2], C. Gendrin[2], J. Spoerk[2], M. Figl[2], D. Georg[1,2], W. Birkfellner[1,2]

[1]Christian Doppler Laboratory for Medical Radiation Research for Radiation Oncology, Vienna, Austria

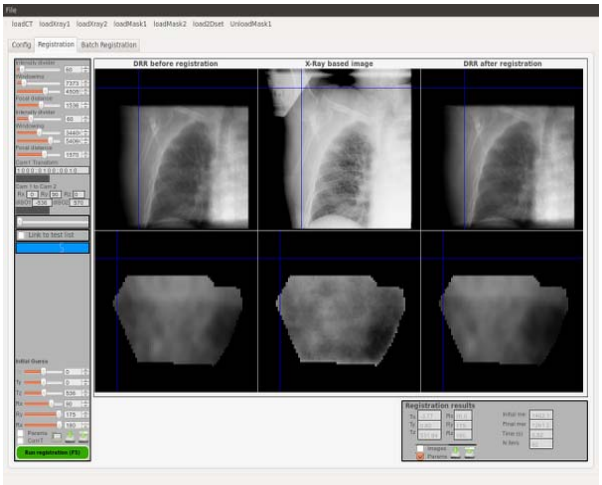
[2]Medical University of Vienna, Center for Medical Physics and Biomedical Engineering, Vienna, Austria

Purpose/Objective: Despite continuous efforts, intra-fraction tumor motion management remains a rather unsolved issue in radiooncology. Real-time tumor tracking or monitoring motion during patient irradiation can help to increase accuracy of dose delivery, to improve OAR sparing, to target the tumor with time variable fluence pattern, or as QA procedure.

Motivated by enormous progress in imaging capabilities and computing power, purely intensity based image registration has shown very good results for tumor tracking. Despite that, research is often based on custom built software solutions with high development times with researchers focusing less on actual studies. We have developed a software suite aiming at IGRT research, specifically for intra-fractional tumor motion management. The software can be used as an easy platform for performing retrospective patient studies or for performing own developments.

Materials and Methods: FLIRT is an open source software suite, freely available to researchers, written in C++ using the Qt framework and implementing GPU optimizations using CUDA. The design principle focused on high performance, flexibility and usability. The core of FLIRT is the intensity based 2D/3D registration approach. It is an optimization procedure, registering DRRs generated from 3D volumes into x-rays acquired from a LINAC. Similarity between the DRRs and x-rays is measured through a merit function. An optimizer searches for the spatial transform generating the DRR which is most similar to the x-ray.

Results: FLIRT is able to perform 6 DOF registration with frame-rates up to 12Hz, depending on the image parameters. The geometry of the imaging system can be configured in a flexible manner. It is possible to use 4 different image similarity metrics, 3 optimizers and to define ROIs with arbitrary shape. The software allows for single registrations as well as image sequence (e.g. fluoroscopy) registration, with the possibility of programming individual parameters (initial guess, image intensity, ROIs) for each image. The resulting tumor position and rotation in 3D space, could be used to gate the LINAC if the tumor is outside a prescribed margin or shift the patient couch. Figure 1 shows a screenshot of the main registration interface. FLIRT was already used in different patient studies. In one study, the tumor positions extracted by registration were compared with marker positions implanted in the tumor. A sequence of fluoroscopy images was loaded in FLIRT and the markers were masked out by a ROI. The tumor position for each image was extracted by registration and the results were directly compared with the tumor position calculated from the markers.



Conclusions: We have developed a software suite for use in image guided radiotherapy research. The software has the potential of enabling researchers to rapidly perform patient studies. In the future, the software will include a plug-in architecture for new algorithm development and a direct connection with a LINAC enabling real-time online studies to be performed.

PO-0931

Evaluation of multiple auto-segmentation solutions against inter-observer variability

Y. Roussakis[1], A. McWilliam[2], A. Hartley[1], P. Sangera[1], H. Benghiat[1], M. Hickman[1], S. Meade[1], A. Zarkar[1], H. Dehghani[3], S. Green[1], G. Webster[1]

[1]University Hospitals Birmingham, Hall Edwards Radiotherapy Research Group, Birmingham, United Kingdom